

Client's ref.: TSMC2003-1006/PE:DCLin
Our ref.: 0503-A30092-USf/Jonah/Steve/Nelson

AUTOMATED SORTER SYSTEM AND METHOD THEREOF

BACKGROUND

The present invention relates to production control technology, and more particularly, to a method and system of performing an automated sorter operation on wafer lots.

A conventional semiconductor factory typically includes multiple fabrication areas or bays interconnected by transportation rails or conveyor belts. Each bay generally includes the requisite fabrication tools to process semiconductor wafers for a particular purpose, such as photolithography, chemical-mechanical polishing, or chemical vapor deposition. The wafers are typically stored in containers, such as cassettes, each of which holds up to 25 wafers. The cassettes are then loaded in carriers, such as standard mechanical interfaces (SMIFs) or front opening unified pods (FOUPs) for transport throughout the factory.

A wafer sorter is a processing tool, used at various points during the semiconductor manufacturing process to perform a number of different functions. One of the functions is to

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transfer one or more wafers between the various cassettes positioned within the wafer sorter. The wafers can be transferred between the cassettes in the same order or reordered as desired. Another function is to map the location of wafers within a cassette, and to detect incorrect positioning of wafers within a cassette.

A wafer sorter operation can be preset to perform necessary carrier exchange from a front-end to a specified back-end carrier. Alternatively, wafer sorter operations such as exchanging a dirty carrier with a clean carrier can be executed dynamically. Several wafers from different carriers can be combined into one to save space, and increase dispatching efficiency. Additionally, wafers from one carrier can be separated into more than one carrier.

A typical semiconductor manufacturing facility processes thousands of wafers at any given time. The wafers are typically divided into lots that undergo different processing sequences. Wafer lots are typically divided into three categories during the manufacturing process: normal, on hold, and in bank during the manufacturing process. Normal wafer lots are ready to

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undergo an operation using a particular tool, while held and
banked lots are stocked and unable to undergo any operation.
Thus, held and banked wafer lots are unable to undergo a sorter
operation via manufacturing execution system (MES), carrier
5 management system or monitor automation system.

To address the above limitation, an operator manually sorts
held or banked wafer lots and carries the lots to a wafer sorter
loadport. The wafer sorter is then switched to manual mode, and
a relevant recipe for performing a particular sorter operation
10 is input through the panel. The wafer lots are subsequently
returned to their original location. Although functional, the
conventional method has several drawbacks including heavy
reliance on human labor, thus, hindering the ultimate goal of
full automation. It is noted that manual operations cannot be
15 tracked by computer and held or banked wafer lots may be lost
due to operator error. Additionally, forced manual interruption
of a wafer sorter may reduce its utility.

In view of these limitations, a need exists for a system
and method of automated sorter operation that reduces lot
20 handling cycle time and improves efficiency.

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SUMMARY

It is therefore an object of the present invention to provide a system and method of automated sorter operation to reduce lot handling cycle time and improve wafer sorter efficiency.

According to the embodiment of the invention, the system includes a wafer sorter, a transport system, and a sorting apparatus. The wafer sorter includes a computer arrangement coupled to a manufacturing execution system (MES). The computer arrangement controls the internal functions of the machine and can process instructions from the MES when changes must be made during processing of current wafer lots. It also has recipe functionality such that wafers are grouped in response to instructions from the internal program or from the sorting apparatus. The wafer sorter can be programmed to manipulate multiple carrier sets for large set slot mapping, exchange, splits, and combinations. The transport system moves carriers containing wafer lots from one site to the wafer sorter based on instructions from the MES during the manufacturing process.

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The sorting apparatus includes a central processing unit (CPU), a memory, and a storage device. The CPU, controlled by instructions received from the memory and from an operator through the input device, directs automated sorter operations.

5 The storage device stores multiple process records and each preferably includes a current status and hold/bank information. The memory preferably includes a sorting module and stored routines for wafer sorting operations on held or banked wafer lots.

10 The sorting module first receives a wafer lot identity, and next, acquires the current status and corresponding hold/bank information from the process record. The sorting module subsequently stores the wafer lot identity, current status, and corresponding hold/bank information into a temporary file or

15 table. The wafer lot is determined to be on hold, in a production or in a non-production bank according to the current status. The sorting module issues a status setting instruction corresponding to the current status to the MES to release it. The MES follows standard procedural steps to release the wafer

20 lot.

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Thereafter, the sorting module creates a floating process flow and assigns the wafer lot to the flow by issuing instructions to the MES. The floating process flow is created during a predetermined process routing to perform dynamic sorter operations, such as slot mapping, carriers exchange, wafer lot combination, or splits. Relevant sorting recipe data corresponding to the sorter operation is also provided in the floating process window. The MES applies the tool dispatch rule according to specific sorter constraints to determine if the wafer sorter is performing the specified sorter operation. Accordingly, the MES starts the transport system to transport the wafer lot to the wafer sorter, and the wafer sorter to perform the sorter operation based on automated sorting recipe instructions.

When sorting is complete, the sorting module acquires the current status and corresponding hold/bank information of the wafer lot from the temporary file or table. The sorting module then issues a status setting instruction corresponding to the current status to the MES to hold or bank the wafer lot. Finally,

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the sorting module removes the temporary file or table from the storage device.

BRIEF DESCRIPTION OF THE DRAWINGS

The aforementioned objects, features and advantages of
5 this invention will become apparent by referring to the following detailed description of the preferred embodiment with reference to the accompanying drawings, wherein:

Fig. 1 is a diagram of the architecture of the system for automated sorter operation according to the present invention;

10 Fig. 2 is a flowchart showing an exemplary wafer lot manufacturing process according to the present invention;

Fig. 3 is a flowchart showing the method of automated sorter operation according to the present invention;

Fig. 4 is a diagram of a storage medium for storing a
15 computer program providing the method of automated sorter operation according to the invention.

DESCRIPTION

Fig. 1 is a diagram of the architecture of the system for automated sorter operation according to the present invention.

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The system 10 includes a wafer sorter 11, a transport system 12,
and a sorting apparatus 13.

The wafer sorter 11 is located near a bay and sorts wafers
in an enclosure. The wafer sorter 11 has a computer arrangement
5 therein coupled to a manufacturing execution system (MES) (not
shown). The computer arrangement controls the internal
functions of the machine and processes instructions from the MES
when changes must be made during processing of current wafer
lots. An included recipe function groups wafers in response to
10 instructions from the internal program or from the sorting
apparatus 13. Other recipe functions include externally guided
recipes and on-demand internal recipes, which can be combined
with other system functions including cassette type balancing,
cassette cleaning, and empty cassette integration. The wafer
15 sorter 11 can be programmed to manipulate multiple carrier sets
for large set slot mapping, exchange, splits, and combinations.

The transport system 12 moves carriers containing wafer
lots from one site to the wafer sorter 11 based on instructions
from the MES. Wafer carriers are typically input to the
20 transport system 12 using automated equipment. Automated

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equipment is also used to remove wafer carriers using the
equipment loadport as the exit point, with the transport system
12 and/or removal equipment designed to allow several wafer
carriers to accumulate near locations while preventing
5 collisions between adjacent wafer carriers.

The sorting apparatus 13 includes a central processing unit
(CPU) 132, a memory 133 and a storage device 131. The CPU 132
is connected by a bus 134 to the memory 133, a communication
device (not shown), an input device (not shown), and a display
10 device (not shown) based on Von Neumann architecture. The CPU
132, memory 133, storage device 131, display device, input
device, and communication device may be conventionally coupled
to a mainframe computer, a mini-computer, a workstation
computer, or a personal computer.

15 The CPU 132, controlled by instructions received from the
memory 133 and from an operator through the input device, directs
automated sorter operations.

The storage device 131 can be implemented as a database
system, a file, or the like, to store multiple process records
20 of wafer lots. The process record preferably includes a current

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status and hold/bank information. The current status of the process record enables lot tracking to determine if wafer lots are on hold or in bank. If wafer lots are on hold, hold information, such as time, reason, note, operator, department, or others, is recorded. The bank information includes data similar to the hold information. Consistent with the scope and spirit of the invention, additional or different contents may be provided in the hold/bank information. Furthermore, the banked wafer lots are divided into two categories, "production" and "non-production". Wafer lots in bank at the start or end of an operation are referred to as "production" lots. Conversely, wafer lots in bank between the start and end of an operation are referred to as "non-production" lots.

Fig. 2 is a flowchart showing an exemplary wafer lot manufacturing process according to the present invention. The predetermined process includes a start operation S211, operations S212, S213, and an end operation S214. Operations S212 and S213 execute wafer manufacturing tasks with a particular machine if required. In the preferred embodiment, while a wafer lot is in a process routing, in step S221, the wafer

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lot is held for inspection, and, in step S222, is banked for several hours due to a quality issue. The current status of wafer lot is set to "on hold" and "in non-production bank" in step S221 and S222 respectively. After step S214, the wafer lot is banked
5 as in step S223, and the current status is recorded to "in production bank". Conventionally, the wafer lot in step S221, S222, or S223 cannot be processed until it is released. According to this invention, the system 10 is provided to execute wafer sorter operations such as in step S231, S232, and S233 for
10 held or banked wafer lots to reduce lot handling cycle time.

The memory 133 is preferably a random access memory (RAM), but may also include read-only memory (ROM) or flash ROM. The memory 133 preferably includes a sorting module 1331 including routines to perform wafer sorting functions for held or banked
15 wafer lots.

The sorting module 1331 first receives a wafer lot identity, then, acquires the current status and corresponding hold/bank information from the process record. Wafer lot identity may be input by an operator via a user interface, or
20 a computer system, such as a carrier management system, a monitor

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automation system or others. The sorting module 1331
subsequently stores the wafer lot identity, current status, and
corresponding hold/bank information into a temporary file or
table. The wafer lot is determined to be on hold, in a production
5 or in a non-production bank according to the current status. If
the wafer lot is on hold as in step S221, it is set to "hold
release" by issuing a status setting instruction to the MES.
Similarly, if the wafer lot is in a non-production bank as in
step S222 or a production bank as in step S223, it is sequentially
10 set to "hold release", "non-production bank out" or "hold
release", "bank move/bank in cancel" respectively by status
setting instructions. The MES follows standard procedural steps
to release the wafer lot.

Subsequent to release, the sorting module 1331 creates a
15 floating process flow and assigns the wafer lot to the flow by
issuing instructions to the MES. The floating process flow is
created during a predetermined process routing to perform
dynamic sorter operations, such as slot mapping, carriers
exchange, wafer lot combination, or splits. Relevant sorting
20 recipe data corresponding to the sorter operation is also

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provided in the floating process window. The MES applies the tool dispatch rule according to specific sorter constraints to determine if the wafer sorter 11 is performing the specific sorter operation. Accordingly, the MES starts the transport
5 system 12 to transport the wafer lot to the wafer sorter 11, and for sorter operations based on automated sorting recipe instructions.

When sorting is complete, the sorting module 1331 acquires the current status and corresponding hold/bank information of
10 the wafer lot from the temporary file or table. Similarly, if the wafer lot is on hold prior to sorting, the wafer lot is set to "hold lot" by issuing the status setting instruction to the MES. In the same way, if the wafer lot is in a non-production or a production bank, the wafer lot is sequentially set to
15 "non-production bank in", "hold lot", or "bank in/bank move", "hold lot". The MES then determines a destination, such as a processing machine or a stocker, for the wafer lot using the tool dispatch rule. The MES starts the transport system 12 to transport the wafer lot to the destination using automated

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instructions. Finally, the sorting module 1331 removes the temporary file or table from the storage device 131.

Fig. 3 is a flowchart showing the method of automated sorter operation according to the present invention. The method begins
5 in step S311 by receiving a wafer lot identity. In step S312, current wafer lot status and corresponding hold/bank information is stored in a temporary table or file in storage device 131. The hold/bank type of wafer lot is determined as
10 in step S313 according to the current status. If the wafer lot is on hold, the process goes to step S321 to set the wafer lot to "hold release" by issuing the status setting instructions to the MES. Additionally, the process goes to step S322 to set the wafer lot to "hold release" and "non-production banked out" sequentially, or step S323 to set status to "hold release" and
15 "bank move/bank in cancel" sequentially if the wafer lot is in non-production bank or in production bank. Thus, the MES follows standard procedural steps to release the wafer lot.

Subsequent to release, the process proceeds to step S331 to create a floating process flow and assigns the wafer lot to
20 the flow by issuing flow instructions to the MES. The floating

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process flow includes a sorter operation step, such as slot mapping, carrier exchange, wafer lot combination, or splits, with relevant sorting recipes. The MES follows standard procedural steps to create the floating process flow and assigns
5 the wafer lot to the flow. The tool dispatch rule is applied according to specific sorter constraints to determine the target wafer sorter 11. In step S332, the MES starts the transport system 12 to transport the wafer lot to the target wafer sorter, and the wafer sorter 11 to perform the sorter operation based
10 on automated sorting recipe instructions.

When sorting is complete, the process goes to step S341 to acquire the current status and corresponding hold/bank information of the wafer lot from the temporary file or table. The original hold/bank type of wafer lot is determined as in step
15 S351 according to the current status. If the original wafer lot is on hold, the process goes to step S361 to set the wafer lot to "lot hold" by issuing the status setting instructions to the MES. In addition, the process goes to step S362 to set the wafer lot to "non-production banked in" and "lot hold" sequentially,
20 or step S363 to set that to "bank move/bank in" and "hold lot"

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sequentially if the original wafer lot is in non-production bank or in production bank. The MES follows standard procedural steps to hold or bank the wafer lot. Finally, in step S371, the temporary file or table is removed from the storage device 131.

5 The invention additionally discloses a storage medium for storing a computer program providing the disclosed method of automated sorter operation, as shown in Fig. 4. The methods and system of the present invention, or certain aspects or portions thereof, may take the form of program code (i.e., instructions)
10 embodied in tangible media, such as floppy diskettes, CD-ROMS, hard drives, or any other machine-readable storage medium, wherein, when the program code is loaded into and executed by a machine, such as a computer, the machine becomes an apparatus for practicing the invention. The methods and apparatus of the
15 present invention may also be embodied in the form of program code transmitted over some transmission medium, such as electrical wiring or cabling, through fiber optics, or via any other form of transmission, wherein, when the program code is received and loaded into and executed by a machine, such as a
20 computer, the machine becomes an apparatus for practicing the

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invention. When implemented on a general-purpose processor,
the program code combines with the processor to provide a unique
apparatus that operates analogously to specific logic circuits.

Although the present invention has been described in its
5 preferred embodiments, it is not intended to limit the invention
to the precise embodiments disclosed herein. Those who are
skilled in this technology can still make various alterations
and modifications without departing from the scope and spirit
of this invention. Therefore, the scope of the present invention
10 shall be defined and protected by the following claims and their
equivalents.